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Launching 10,000-Ton Cargo Vessels

By Paul G. A. Brault, M.E.I.C., *United Shipyards Limited, Montreal*

(Continued from July Issue)

Previous to pivotting, the keel line and the bottom of the poppet block are parallel to the groundways. During pivotting, the angle between the bottom of the poppet block or keel and the groundways changes from 0 to about 3 deg. Theoretically, if the vessel and cradle were absolutely rigid an infinitely small angle between the keel line and the groundway would cause all the load on the ways to be concentrated at a single point of contact. This load would be equal to the launching weight (W) less the buoyancy (B) at that instant. Since the vessel is not absolutely rigid the poppet load therefore cannot be 750 tons as static calculations showed. Keeping in mind the fact that as the launch proceeds the angle between the keel and groundways is continually increasing, but that at the same time the load on the ways ($W-B$) is continually diminishing, there comes a time when the change of angle is sufficient to overcome the elasticity of the vessel and the load on the groundways actually becomes concentrated. The crushing block arrangement is a deliberate effort to create a non-rigid space, of fixed length, between the hull and the groundways which will take the change of angle and spread the load uniformly over a known length.

The method used in proportioning the crushing blocks is as follows:—

(a) Determine a graph of the unit stress per square inch required to obtain various percentages of crushing of the blocks to be used. (Several tests were made with clear spruce wood. The average of these tests is shown in Table I).

(b) From the static launching calculations determine the angle (a) between the keel and groundways and the load ($W-B$) on the ways for various travels after pivotting has commenced.

(c) Assume a depth of crushing blocks and determine the amount of crushing (D in.) at the forward end of the poppet. This crushing should be about 35 per cent of the depth of blocking.

(d) For each travel in (b) determine the length (L) of poppet in contact with the ways assuming that the full crushing (D) has taken place.

$$L = \frac{D}{\tan a}$$

(e) For each travel in (b) determine the load (P) per square foot on the ways.

Then $P = \dfrac{W-B}{L\,b}$ where b = width of sliding ways in contact.

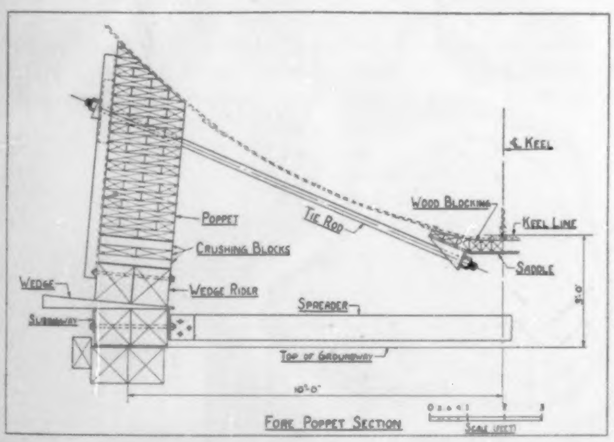

Fig. 7—Section at forward end of fore poppet.

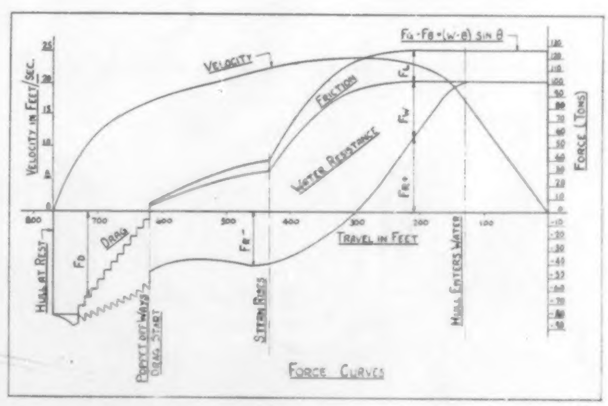

Fig. 8—Calculated force and velocity curves plotted on a travel base.

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It will be found that this quantity (P) increases to a maximum as the travel increases and then begins to diminish with further increase in travel. The permissible load on the groundway lubricant is about 10 to 11 tons per sq. ft. Should the maximum calculated load P be higher than this, the depth of crushing blocks must be increased and the calculations repeated till found satisfactory. At the travel at which the maximum pressure per square foot occurs the quantity L represents the required length of poppet block.

(f) With a poppet of length L and crushing at its forward end equal to D, the crushing Dz at any intermediate block distance z from the aft end will be $\frac{z}{L} \times D$. From Table I the pressure per square inch to obtain Dz may be found.

(g) Since the pressure per lineal foot of poppet equals $P \times b$, it follows from f) that the area of crushing blocks required for each foot of poppet is known. For practical reasons, it is better to fix the area of blocking and vary its spacing rather than vary the blocking area at a uniform spacing.

TABLE I

Table showing percentages of deformation of clear spruce blocking when subjected to various unit pressures.

Pressure in lbs. per sq. in.	Crushing percentage of depth
100	0.83
200	1.67
300	2.50
400	3.83
500	8.33
600	17.50
700	26.67
800	35.83
900	45.00

In the design (Fig. 6) D was assumed 3.6 in. This gave a maximum P of 10.4 tons per sq. ft. occurring at a travel of 87 ft. beyond the static pivotting point. The angle was 1 deg. 13 min. giving a length L of 13.7 ft. The total poppet load at this position of maximum unit pressure was 520 tons.

The poppet block is 23 in. wide and is built up with layers of 3 in. planks thoroughly nailed together. It was constructed in the shop and the top surface carved to the hull shape from mould loft templates.

Since the poppet load must necessarily be carried by the sliding

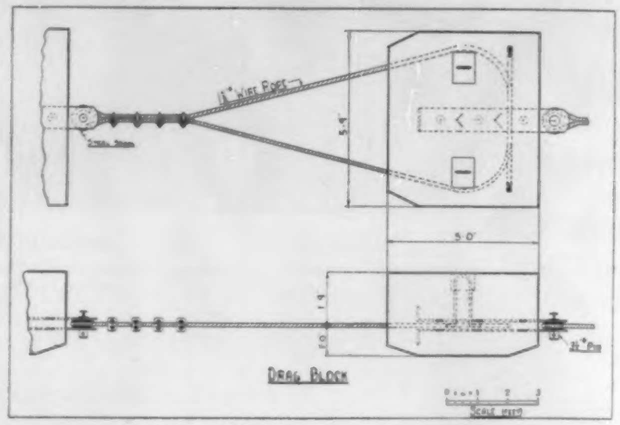

Fig. 9—Detail of 5-ton concrete drag block.

ways, the stresses there are at right angles to the wood grain. There appeared to be no object therefore to construct the poppet block of stronger end on timbers with stresses parallel to the grain.

Figure 7 shows a cross section at the forward end of the fore poppet. Note the staggered arrangement of the poppet block planks. The tie rods are 2⅜ in. diameter steel rounds threaded at both ends but not upset. A thick steel pad is used at the upper end of the tie rod to properly distribute the load to the timber. The saddle plates are 6 by ½ in. with welded brackets.

THE LUBRICANTS

The lubricants used are Paragon stearine as base coat and Paragon grease as slip coat. These are mineral products developed exclusively for launching purposes. The base coat serves to smooth out any unevenness in the groundway timbers and is tough enough to resist the launching loads without squeezing out or disintegrating.

The base coat is ¼ in. thick and, in order to obtain good adherence, is applied when the groundways are thoroughly dry. To lay the base coat the groundways are first cleaned and divided into rectangular areas by 1 by ¼ in. wood slats lightly nailed at about 4 ft. centres. The stearine is then melted and each rectangular area filled by pouring on the melted stearine with hand ladles. The slats are then removed and the spaces so left are also filled, after which the whole area is smoothed off with hot irons. A brush coat of stearine is also applied to the underside of the sliding ways.

A ¼ in. thick layer of slipcoat is smeared on by hand on top of the base coat before placing the sliding ways in position. No grease irons are used. The 1 in. clear space between the ribband and the

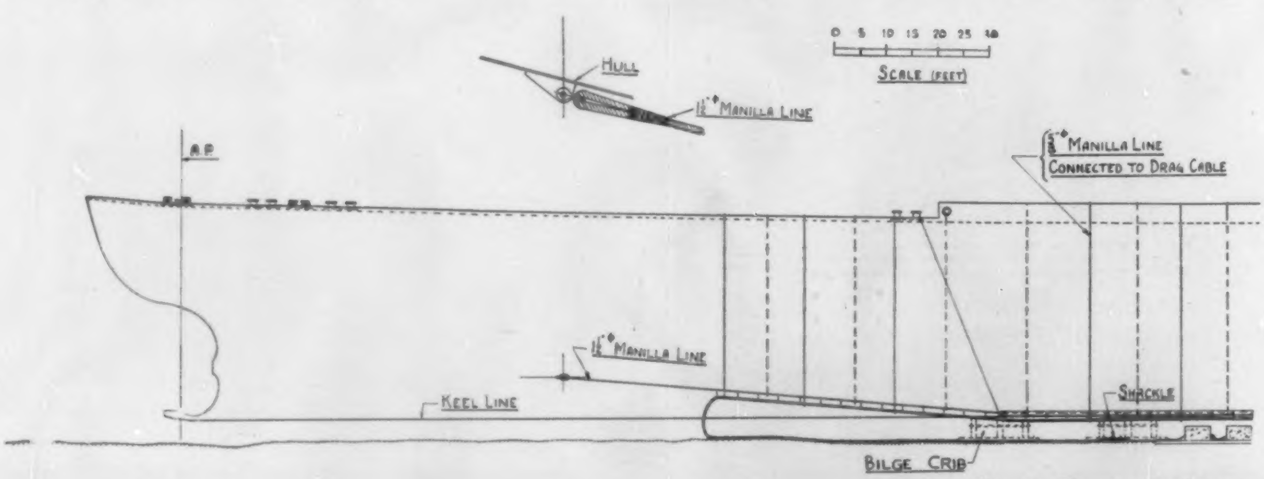

Fig. 10—Elevation showing arrangement

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Bulletin on Test Methods for Determination of Low Temperature Characteristics of Lubricating Greases

The Joint Committee of the Annular Bearing Engineers and the National Lubricating Grease Institute Technical Committee has recently issued a Bulletin on Test Methods for the Determination of Low Temperature Characteristics of Lubricating Greases. This Bulletin contains discussions of the following items:

(1) Tentative Method for Determination of Low Temperature.
Torque Characteristics of Greases in Anti-Friction Bearings.

(2) S.O.D. Pressure-Viscosimeter.

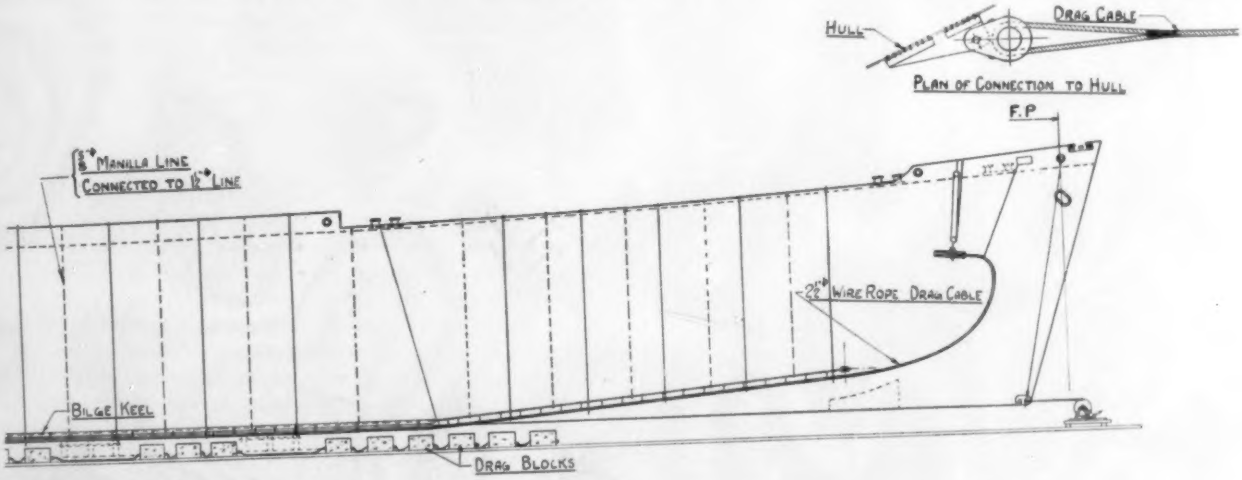
(3) S.O.D. Pressure - Viscosimeter for Low Temperatures.

(4) The Measurement of Low Temperatures by Thermal Electrical Procedures.

Copies of this Bulletin have been distributed to all members of the Annular Bearing Engineers Committee, the National Lubricating Grease Institute Technical Committee, all members of the Institute and to many Government and industrial laboratories engaged in the testing of lubricating greases.

A limited number of these Bulletins is still available and additional copies may be procured from G. W. Miller, N.L.G.I. Secretary, at $1.00 each.

In placing orders for copies of this Bulletin, please forward cash with the order to minimize clerical and accounting work.



Drag Cable & Drag Blocks

of drag cable and drag blocks.

sliding ways is packed with grease before applying the covers.

Three successful launchings in one summer season have been made on the same base coat without any appreciable reduction in its thickness. After a winter season, however, it is better to renew the base coat entirely. The removed base coat may be melted, strained and salvaged for re-use.

A fresh new slip coat is used at every launch. After launching the grease is scraped up and discarded as it cannot be salvaged and is no longer serviceable.

FORCE CALCULATIONS

In order to obtain some conception of the amount of drag needed to bring the vessel to rest immediately after the launch and the amount of travel that drag would require, it was necessary to make force calculations based on the static launching computations.

The force acting upon the vessel at any time during the launch may be expressed as follows:—

$$F_R = F_G - F_B - F_L - F_W - F_D$$

F_R is the net resultant force in tons and may, without appreciable error, be considered acting parallel to the ways during the launch and parallel to the water after the launch.

F_G is the component of launching weight down the ways and equals $W \sin \phi$ where W equals the launching weight in tons and ϕ the angle of inclination of the ways.

F_B is the component buoyancy down the ways and equals $B \sin \phi$ where B is the buoyancy in tons. Note that $F_G - F_B = (W - B) \sin \phi$ or the net load on the ways $\times \sin \phi$ at any time.

F_L is the frictional resistance of the lubricant and equals $f\ (W - B) \cos \phi$ where f is the coefficient of friction. The coefficient f was assumed as 0.01, a deliberately low figure in order to obtain the most unfavourable condition for the drag.

F_W is the water resistance of the vessel and equals Kv^2 where v is the velocity of the vessel in feet per second and K a coefficient. In the calculations made, the value of K suggested by Henry H. W. Keith in

Fig. 11—View of bow of vessel showing starboard fore poppet and connection of drag cable to hull.

Principles of Naval Architecture, Rossell and Chapman, Vol. 1, was used.

F_D is the drag resistance and is equal to kD where D is the weight of drag in tons and k its coefficient of friction on the ground. Both quantities must be assumed and if results are not satisfactory the assumption must be altered until it is so.

F_D was assumed as twelve equal weights of 10 tons each, adding successively to one another. Coefficient k was assumed equal to 0.65. The resulting force and velocity computations are shown in Fig. 8.

THE DRAGS

The use of bundles of heavy chain for drag weights is the most common practice. United Shipyards, being a new yard, did not possess any chain and it was not thought expedient to either borrow or lease chain from other yards even if any was available. The decision was therefore made to use concrete blocks as drag weights.

In order to complete the force calculations, it was necessary to determine the friction coefficient of the blocks on the terrain they had to travel upon. This terrain was partly on concrete and partly on hard packed gravel. Accordingly, tests were made with a concrete block weighing 3650 lb. on conditions similar to those anticipated by the actual drag. These tests indicated a friction factor of about 0.65, a figure used in the computations.

The force calculations showing that twelve increments of 10 tons of drag would be suitable, it was decided to use twelve 5-ton concrete blocks on each side of the vessel. Each block is proportioned for needed volume to obtain the required weight, the only fixed dimension being the depth in order to permit driving of the wedges immediately behind the block. The blocks are shown in Fig. 9. Each block weighs 5 long tons. When extended, the distance from the centre of connecting pin to face of block is generally 13 ft. but blocks adjacent to the upper ends of bilge cribs have this length increased by 10 ft. The wire rope engages a steel spool which bears on the 3½ in. diameter connecting pin. The pin, in turn, bears on the embedded anchor plates. Lifting hooks are depressed in pockets to provide a clear surface on the top of the block so that the cradle wedges may be driven. The connections between the blocks are designed for 100 per cent of the weight of all the drag on one side of the vessel. A factor of 3 on the ultimate strength of the wire ropes was used and the steel parts proportioned at 20,000 lb. per sq. in. All blocks were made similar for complete interchangeability. The wire rope was arranged to straddle the width of the block, and placed below the vertical centre of gravity in order to obtain maximum stability and minimum liveliness as the block is set in motion.

The initial position of the blocks is such that each has 10 ft. of movement before picking up the succeeding one. Transversely, the two sets of drags are at 35 ft. centres. A 3 by 8 wood guard rail was built off the outboard ends of the ribband wedge timbers due to the closeness of the inboard edge of the drag blocks. This rail extends from the uppermost drag block to the end of the groundways.

THE DRAG CABLES

The drag cable must be of such a length that it will pick up the first drag block only after the launching cradle has left the end of the groundways. With the position of the first block determined, the resulting length of drag cable required is 404 ft.

It is necessary to control each drag cable so that it will not foul the staging towers (2 ft. away) during the launch and will not kink as it straightens out to pick up the drag. Several methods of tying up the drag cable were considered, the final arrangement being as depicted in Fig. 10.

The 2½ in. diameter wire rope drag cable weighs about 10 lb. per ft. and is 404 ft. long bight to bight of the 6-ft. spliced loop at its ends. The bilge cribs, drawn in dotted lines, are in way of the drag blocks thus necessitating the disposition of blocks shown. The con-

nection of the gauge wire used to obtain the time-distance curve of the launch is indicated at the bow. A small loop at the end of the gauge wire was passed through the paravane hole and engaged a steel pin held by a light manilla line to the upper deck. Drawing up the pin freed the vessel whereupon the gauge wire was reeled back in.

To eliminate transverse sway, a 1½ in. diameter manilla rope connected at either end to temporary welded brackets is strung along the vessel's side and supported to the upper deck by ⅝ in. diameter manilla rope at 15 to 20 ft. intervals. The ¾ in. wire rope tag lines connected to the cradle (Fig. 3) pass over this 1½ in. line thereby holding it closely to the vessel. The drag cable is also tied at 15 to 20 ft. intervals by ⅝ in. diameter manilla ropes which pass over the sharp edges of the upper shell plate strake. The drag cable is further tied to the 1½ in. manilla line by light strands at 5 to 6 ft. centres. As the vessel slides down the ways, the cable ties break successively, thus uniformly paying out the cable to the ground.

The drag cable is connected to the bow of the vessel by a shackle which is pinned to a bolted steel bracket. The centre to centre distance between brackets is the same as port and starboard spacing of the drags on the berth. This connection and the fore poppet are shown in Fig. 11.

As the ship comes to rest under the influence of the drags, the elasticity of the cables causes the vessel to move forward slightly thus slackening the cables. At this moment the connecting pins are pulled out by the attached tackles and the shackles allowed to drop to the basin bed. The 1 in. wire rope connecting the shackles to the sliding ways (Fig. 3) thus anchors the cradle to the drag. A ¼ in. wire rope is also attached to each shackle and is of sufficient length to float a wood buoy at its other extremity.

After the vessel has been hauled off the cradle, men on rafts equipped with hand winches pick up the ¼ in. lines, raise the shackles from the bottom of the basin into the rafts and disconnect the 1 in. line to the sliding ways. After detaching the cables at the first drag block they are pulled inshore, coiled and stored for later use.

Launching

A schedule which lists all operations required is prepared for each launch. The principal items on the schedule include placing the drag blocks, removing the aft end staging, removing the stoplogs and bents, inspection by divers of the submerged groundways, tying up of the drag cable, driving the wedges, removing keel blocks and shoring, removing bilge cribs, ribband covers, thumbplates and burning of the sole plates.

All launchings with water over elevation 97.0 require the wedges to be driven before stoplogs and bents are removed. Thus it is not infrequent that the weight of the vessel remains on the grease some 24 hours before the launching time. This condition is not desirable but is unavoidable.

The wedges are driven in two separate rallies. Three pairs of rams are used during a rally, one pair at the aft end and the others at the third points of the cradle. Each pair works forward on its alloted number of wedges. Due to the solid rock foundation little trouble is experienced in transferring the weight of the vessel to the groundways. Generally speaking, when the second rally is completed, the keel block wedges may be removed by hand.

Interest in the burning of the sole plates extends even to the burners themselves, who vie with one another for the job. Four burners who have worked on the vessel to be launched are chosen for the operation. Since the basin is tideless, the time of launching may be chosen at will. Usually, launchings occur at the hour which interferes least with the operation of the yard and is of the greatest convenience to the ceremonial party.

Figure 12 is a view taken after the first launch from Berth No. 3. Note that the launching cradle remains anchored to the drag blocks.

Observations

To check the force calculations and also to determine the velocity, starting and running friction of the lubricant, friction of the drag, an arrangement was set up to establish the time-distance curve for each of the first five launchings. The first derivative or slope of the time-distance curve gives the velocity of the vessel and the second derivative or the slope of the velocity curve gives the acceleration of the vessel. The acceleration multiplied by the launching mass gives the resultant force (F_r) acting on the vessel.

The arrangement consisted of a wood reel of known circumference (10.1 ft.) with sufficient gauge wire wrapped around it to extend over the total travel. The gauge wire was connected to the vessel as indicated in Fig. 10. A foot brake was attached to the reel to control its momentum as the vessel's velocity decreased. A small copper plate was inserted in the side of the reel. With each revolution of the reel this plate contacted two poles fixed to the axle supporting frame, thus closing a circuit. The poles were connected to a chronograph which had a magnetically operated pen holder. The pen scribed a continuous line on a paper attached to a drum which revolved at a constant known speed. Each contact the reel made with the poles operated the pen holder magnet thus causing a short side deviation of the line scribed by the pen. A stylus, following in the fresh ink line, was held by a second magnet which could be activated by a separate telegraph key, permitting thereby various independent time observations.

The results obtained are shown in Table II. The time-distance curves did not prove sufficiently accurate to produce a truly reliable second derivative or acceleration curve. As nearly as it could be judged, the friction coefficient of the drags was about 0.35 instead of the 0.65 established by the tests.

Customary sliding way telltales were placed at the aft end, midpoint and fore end of the cradle to determine the liveliness of the vessel before launching.

Nails, driven by the side saddle channels into a wood block fixed to the fore poppet wedge rider, indicated the amount of crushing which had taken place.

At the first launch (Hull No. 2) an attempt was made to establish the travel and time at which actual pivotting occurred. A 16 mm. movie camera was set up on shore and focussed on the stern of the vessel. A second similar camera was set on board the vessel and focussed on the shore line in the distance. Knowing the number of frames per second, the time of pivotting could be determined by viewing the film. An observer at each camera checked the time independently with stop watches. The travel at pivotting was obtained

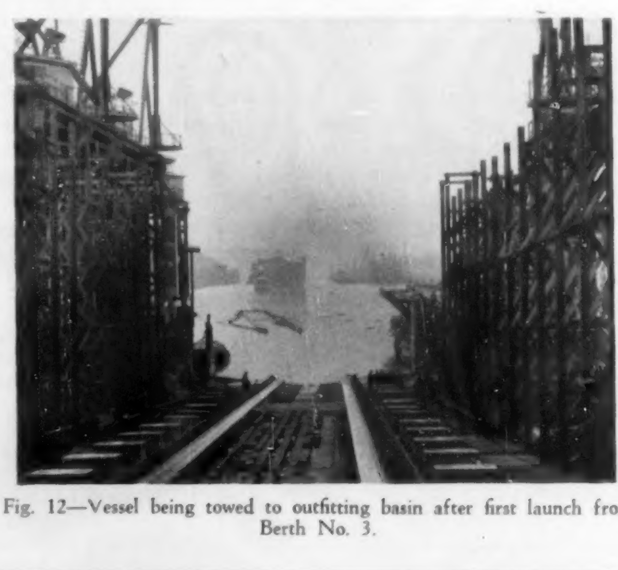


Fig. 12—Vessel being towed to outfitting basin after first launch from Berth No. 3.

from the time-distance curve. Apparently actual pivotting took place about 22 ft. beyond the travel shown by the static launching calculations.

The first launching off Berth No. 3 was followed with great interest due to the water conditions on the port side. The vessel definitely contacted the guard (4 ft. 6 in. lateral movement) just previous to picking up the drag. There was also evidence of the sliding ways rubbing against the port ribband.

Just as Hull No. 3 on Berth No. 1 had come to rest after launching, a very strong wind arose and blew the vessel over to the guard on the east side of Berth No. 3 before the tugs could obtain control. The resulting side strain on the anchored cradle caused the link plates at the sliding way midjoints to sever their cotter pins thus dividing the sliding ways into two sections.

After the wedges had been fully driven under Hull No. 4, strong winds forced postponement of the launch for three days. The weight was therefore carried on the grease for this period of time and in freezing weather. The vessel started off on a successful launch about 15 seconds after breaking its sole plates.

The abnormal travel of Hull No. 5 before coming to rest was due to the drags moving on sanded snow and ice instead of packed gravel. The ice was 6 to 8 in. thick in the basin at the time and, in way of the launch, had previously been broken up into slabs by the tugs.

TABLE II

Observations taken at first five launchings. (Columns indicate the order in which the launchings took place.)

Hull number	2	1	3	4	5
Berth number	2	3	1	4	5
Temperature	57°F	56°F	32°F	28°F	1°F
Water elevation	94.7	94.6	96.0	95.2	95.6
Feet of water over end of groundways	8.9	8.9	9.7	10.0	10.4
Launching weight (long tons)	2520	2490	2490	2450	2250
Initial mean pressure (tons per sq. ft.)	1.94	1.92	1.92	1.88	1.73
Number of drag blocks	24	24	20	16	16
Aft sliding way telltale movement in ins.	0.75	0.75	0.65	0.75	—
Area of sole plate broken (sq. in.)	3.05	3.25	2.44	2.16	2.97
Breaking load (long tons)	84.4	87.0	66.3	57.8	79.5
Inches of crushing at fore end of fore poppet	3.8	3.3	3.1	3.1	3.0
Travels in feet:					
Keel enters water	102	103	76	92	84
Stern rises	402	400	373	—	—
Drags picked up	617	617	603	618	620
Vessel at rest	764	738	736	773	864
Time in seconds:					
Keel enters water	15.5	18.0	21.5	19.0	45.0
Stern rises	30.5	33.0	38.5	—	—
Drags picked up	43.5	47.5	54.5	49.5	79.0
Vessel at rest	66.0	67.0	79.0	70.0	127.0
Max. velocity (ft./sec.)	22.0	22.0	20.0	21.2	20.4
Starting friction factor	4.3	4.2	—	—	—
Running friction factor	1.78	1.56	—	1.78	2.67
Feet of movement of last drag block	37	20	43	92	185

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